ATBD 1995
Thermal Algorithm Dry Run

Additional View Graphs

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4AUG95

Proposed Topic Agenda

Thermal Algorithm Overview
- Objectives
- Comparison with ATBD 1994
- Advanced (Future) Algorithm Concerns
- Error Budget and Summary of Error Analysis Results

MODIS Instrument Overview
- EOS Platform
- Scan Cavity
- Calibrators
- Scan Mirror
- Optical System
- Electronics

ATBD 1995 Thermal Algorithm Description
- Instrument Test Limitations
- Comparison of Traditional and Universal Approaches
- Universal Algorithm
  - Applied Equations
  - Scientific Derivation
- Traditional Algorithm
  - Applied Equations
  - Scientific Derivation
- Data Requirements

Objective

Determine the apparent spectral radiance (with associated uncertainties) for each pixel observed through the Earth view.

Methodology

Use the Space View and OBC Blackbody every scan as reference sources to account for system level gain changes on-orbit. space view used as zero scene radiance reference

Use the temperature of the optics to help correct for optical background drift

Use the detector temperature to help correct for [nonlinearity ~~[illegible]~~ as a function of detector temp]

Use a spacecraft maneuver to help account for relative scan mirror reflectivity variation with respect to angle

Determine nonlinearity of the detector, responsivity of the optics, OBC blackbody radiance, and scan mirror relative reflectivity in pre-launch testing

Determine tracability to NIST

SYSTEM-AMBIENT TESTING LAYOUT IN B32 CLEAN ROOM

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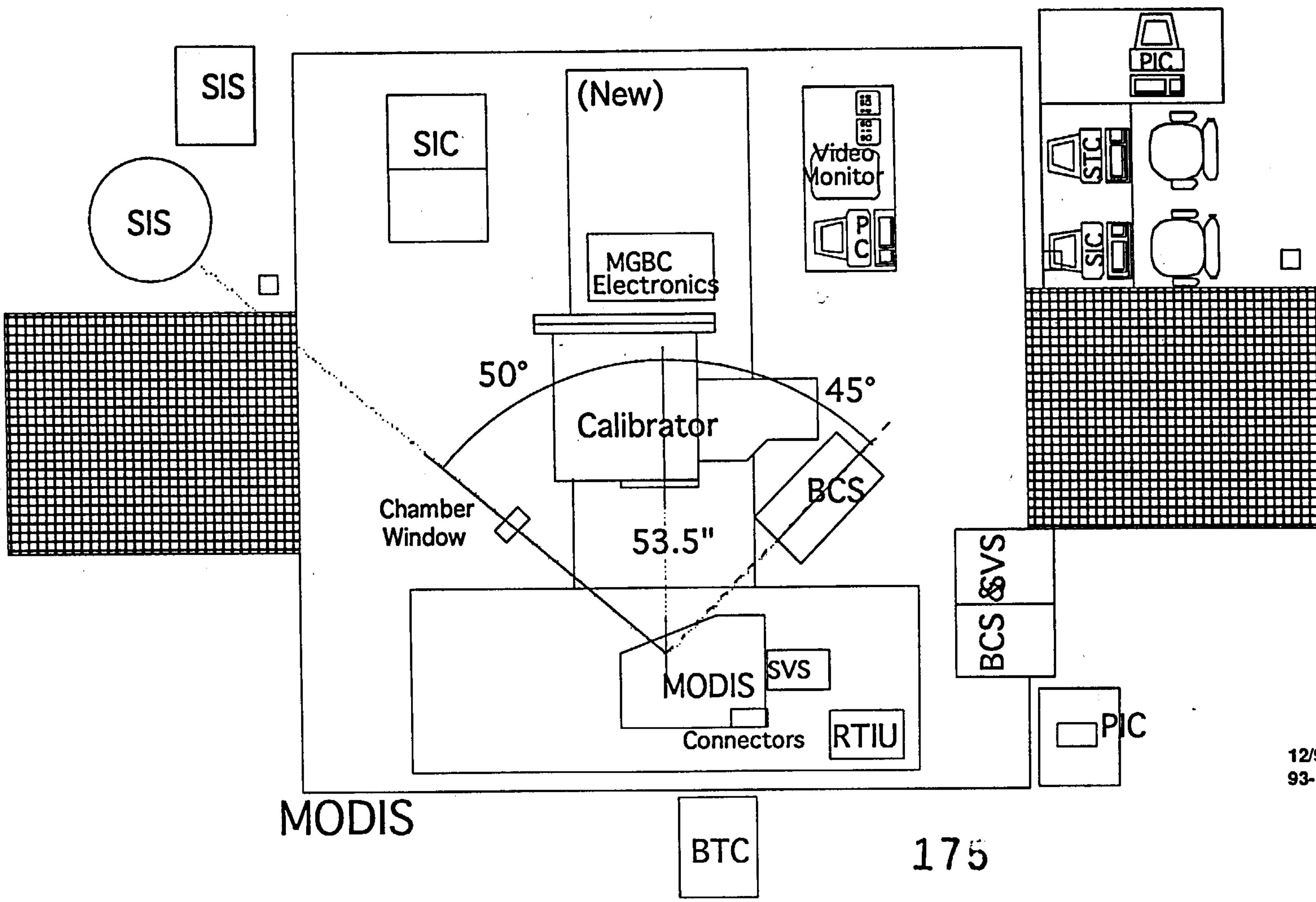

MODIS

12/93
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Scan Mirror Concerns For OBC Blackbody Characterization

		Degrees OBC BB	Degrees BCS	
Band	Wave	26	15.5	Diff BCS to OB(
20	3.75	0.988	0.993	0.005
21	3.959	0.989	0.995	0.006
22	3.959	0.989	0.995	0.006
23	4.05	0.989	0.995	0.006
24	4.465	0.988	0.995	0.008
25	4.515	0.988	0.995	0.007
27	6.715	0.985	0.991	0.006
28	7.325	0.986	0.989	0.004
29	8.55	0.976	0.985	0.009
30	9.73	0.977	0.985	0.008
31	11.03	0.983	0.988	0.005
32	12.02	0.982	0.988	0.006
33	13.335	0.978	0.987	0.009
34	13.635	0.977	0.987	0.010
35	13.935	0.976	0.987	0.011
36	14.235	0.975	0.986	0.011

Example BCS Temperatures To Characterize Nonlinearity and Blackbody Radiance

Temp BCS	Temp OBC Blackbody	Nonlinear Characterization	Blackbody Characterization
250	295	Yes	
265	295	Yes	
280	295	Yes	Yes
295	295		Yes
310	295	Yes	Yes
325	295	Yes	
340	295	Yes	

MODIS Thermal Calibration and Tracability to NIST

Given:

1. For each nominal (could vary a little during the test) instrument temperature and patch temperature we will have 8 external calibration target (BCS) temperatures.

2. The hardware provides system temperatures and 3 signals: the space view source (SVS), the on-board blackbody BB and the BCS.

3. The system is nonlinear: the signal is proportional to a quadratic in radiance from the three sources.

4. The BCS is more accurate than the BB and is hence the standard (truth).

5. The installed BCS and BB thermistors are traceable to NIST

6. The emissivities of the BCS and BB are calculated based upon measured reflectances of the material and geometry.

7. The current test plan calls for:

  -at patch temp 1: 2 instrument temperatures
  -at patch temp 2: 3 instrument temperatures
  -at patch temp 3: 1 instrument temperatures

This is insufficient.

Approach

1. Assume the calibration curve fits a quadratic which is unique to each detector.

2. For the baseline approach signals from the three calibrators are used simultaneously to solve for three parameters which characterize the quadratic for each of the eight BCS ground target temperatures. The three parameters may change at each target temperature (if there are changes in various instrument temperatures during the test) and the 8 non-linear coefficients are averaged to be subsequently treated as a constant in orbit.

3. Possibly, an improved approach would be to perform a least squares fit (LSF) of the 8 BCS measured radiances with those computed from the algorithm. The residuals would be minimized by adjusting the quadratic coefficient and perhaps some other parameters (emissivity of the BB, scan mirror relative reflectance, and scan cavity effective temperature). This approach should be modeled.

Concern:

For the current test conditions the scan mirror reflectance will not be measured accurately enough to allow transfer of the calibration of the BCS to the BB. In order to meet the accuracy requirements and maintain credible tracability it will be necessary know the scan mirror reflectance for the three on-board calibrators pre-launch. We also need the AOI of earth view angles. If the scan mirror reflectance is not measured accurately enough it will not be traceable to NIST.

Observations:

1. Scan mirror relative reflectance will be characterized on-orbit by scans of space through the earth view port if the EOS Project permits it. This should be done periodically to account for contamination of the scan mirror in the calibration algorithm.

2. Credible temperature and radiance tracability of the BB through the BCS to NIST is not possible if 2 relative reflectivities (SVS relative to the BB and BCS relative to BB) of the scan mirror are not determined accurately pre-launch. Temperature and radiiance tracability of the BCS to NIST is possible, but radiance tracabiltiy is not currently planned.

3. The BB provides a parallel temperature tracability to NIST. It could be better than tracing through the BCS if the relative scan mirror reflectances are poorly known. Testing with the BCS is still important to obtain the quadratic coefficients as a function of patch and instrument temperatures.

4. Radiance tracing to NIST may be desirable if sufficiently accurate relative reflectances of the scan mirror can be measured pre-launch.

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INTERNAL MEMORANDUM

TO: J. Mehrten **CC:** Distribution

DATE: 10/20/93
FROM: W. Balinski
BLDG: B32
EXT: 7147
REF: PL3095-R03161
ME-5033

SUBJECT: Scan Motor Event Positions

I generated the following table of actual motor shaft positions with respect to the index position as zero. I don't know if this has been published elsewhere.

MOTOR/ENCODER SHAFT POSITION		EVENT	VIEW ANGLE (NADIR =0°)
0°	MIRROR SIDE 1	INDEX	284°
10.5°		EARTH SCAN START	305°
38°		EARTH NADIR VIEW	0°
65.5°		EARTH SCAN END	55°
129.75°	MIRROR SIDE 2	SD (NOMINAL)	183.5°
141.75		SRCA (NOMINAL)	207.5°
153.7°		BB (NOMINAL)	231.4°
168.585		SPACE VIEW (NOMINAL)	261.17°
190.5°		EARTH SCAN START	305°
218°		EARTH NADIR VIEW	0°
245.5°		EARTH SCAN END	55°
309.75°	MIRROR SIDE 1	SD (NOMINAL)	183.5°
321.75°		SRCA (NOMINAL)	207.5°
333.7°		BB (NOMINAL)	231.4°
348.585°		SPACE VIEW (NOMINAL)	261.17°

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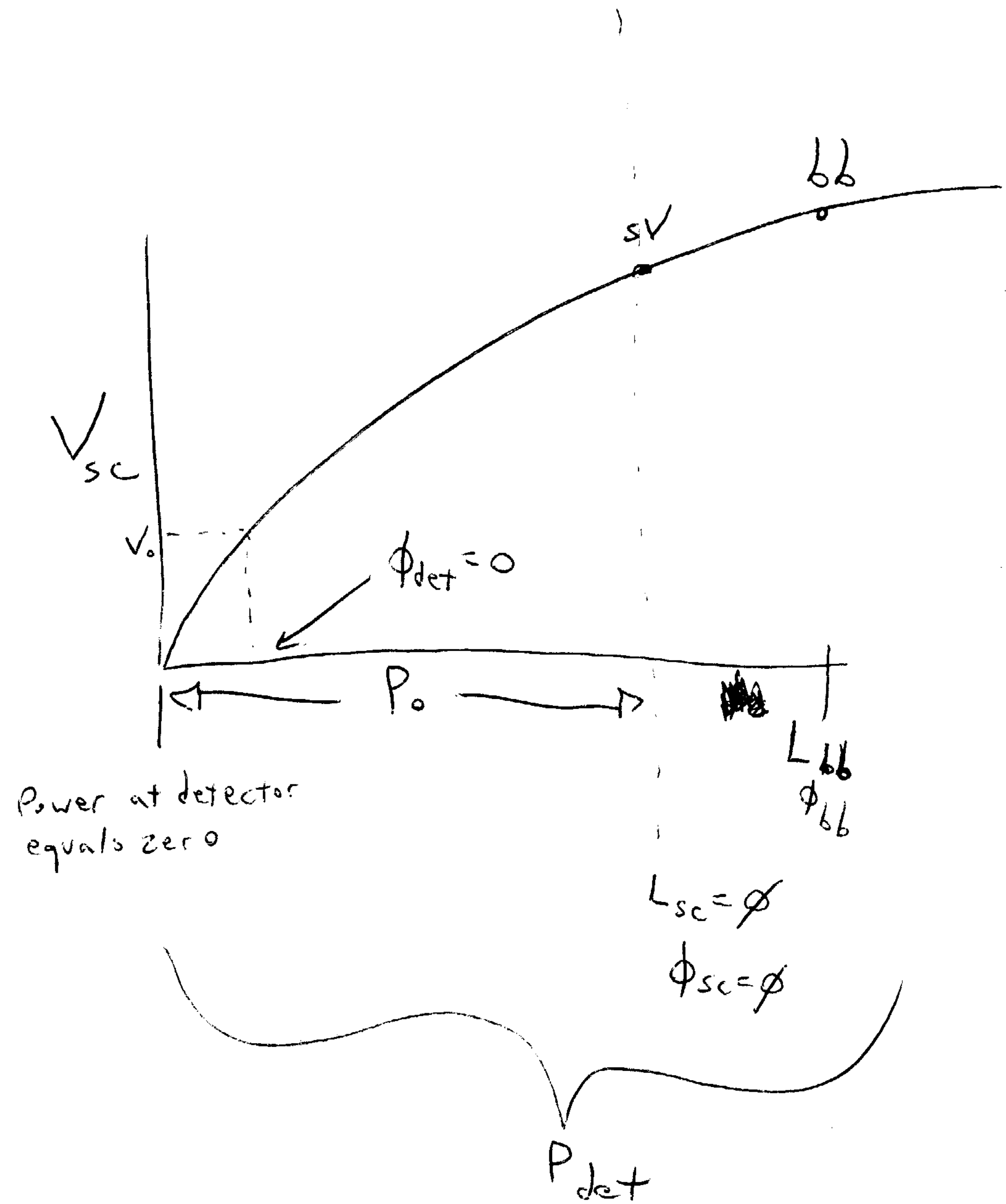

bb
sV
V_{sc}
V_0
$\phi_{det} = 0$
P_0
L_{bb}
ϕ_{bb}
Power at detector
equals zero
$L_{sc} = \emptyset$
$\phi_{sc} = \emptyset$
P_{det}